PROTOCOL DEVELOPMENT SUMMARY

Protocol: NCCN Vital Signs Intertidal Monitoring

Parks where protocol may be implemented: This protocol will be immediately implemented at OLYM. Further implementation of the sand habitat subset of the protocols may proceed at FOCL. A subset of these protocols is being developed in tandem with other NPS west coastal parks (CABR, CHIP, PORE, REDW).

Justification:

Intertidal communities and habitat ranked 8th as a potential vital sign in the NCCN. While marine water quality was not a separate potential vital signs topic under consideration in the NCCN, water quality issues in general ranked very highly (2nd and 7th for stream and lake water quality respectively). Since water quality is major factor determining the health of intertidal communities and is also an emphasis area for NPS-Water Resources Division funding of water quality monitoring, a component of marine water quality is included in the monitoring program presented here (*See Monitoring Objectives section for more thorough discussion of this topic*).

Intertidal invertebrate and algal communities in the intertidal zone of NCCN parks are some of the most productive and biologically diverse on the west coast of North America. At OLYM alone, over 350 species of invertebrates and macroalgae have been recorded in the intertidal zone. These communities are particularly important because of their tight ecological linkage with the nearshore coastal ocean. This tight linkage is manifested in nutrient transport, and direct exchange of organisms between these zones. Most benthic invertebrates and macroalgae have a pelagic life-stage that live in the nearshore coastal ocean and contribute to its highly productive foodweb. Intertidal communities are vulnerable to a host of anthropogenic stressors, such as pollution (e.g. oil spills), harvest, trampling, and global climate change. Intertidal communities are valuable vital signs of important changes in the nearshore marine ecosystem, and are themselves a valuable indicator of marine water quality.

Monitoring Questions & Objectives:

Intertidal Step-Down Framework (* *denotes topic considered but not recommended*)

- Intertidal Zone *Health*
  - Intertidal Organisms
    - Individual Species*
    - Communities
      - Fish*
      - Invertebrate & Macroalgae
        - Mixed-Coarse Habitat (28% of OLYM)*
        - Rock Platform Habitat (21% of OLYM)
        - Sand Beach Habitat (30% of OLYM)
  - Intertidal Habitat

- Water Quality
    - Assorted Parameters (e.g. salinity, pH, DO)*
    - Temperature
    - Invertebrate & Macroalgal communities

Monitoring Questions Associated with Step-down Framework

- What is the *Health* of the intertidal zone? (i.e. What is the status and trend including range of natural variation in key intertidal zone indicators?)
    - What is the status and trend of intertidal invertebrates in rock platform and sand beach habitats?
        - What is the range of natural variation in species richness, abundance and distribution of invertebrate & macroalgal communities and their constituent species?
        - What is the trend in elevational pattern of invertebrate and macroalgal community structure (i.e. richness, abundance)?
    - What is the long-term trend in intertidal temperature regime?
    - What is the temporal change in physical habitat type and distribution?
    - What are the long-term trends in summer nearshore water quality parameters (e.g. salinity, pH, Do, Temperature)?* (*Note: these data are to be obtained from nearshore NOAA monitoring buoys*)

Monitoring Objectives:

1. Determine the range of natural variation in species richness, abundance and distribution (elevational and coast-wide) of intertidal invertebrates and macroalgae in rock platform and sand beach habitats. ***Justification*****:** *The diverse intertidal invertebrate and macroalgae assemblages present in the NCCN are primary space occupiers in the intertidal zone and have a tight ecological linkage to nearshore ocean processes and productivity. These organisms are also integrative indicators of nearshore marine water quality in much the same way that benthic macroinvertebrate communities are for freshwater streams. The elevational distribution of organisms is determined by a combination of physiological tolerances, competition and predation. Changes in marine water quality, interspecies interactions or mortality patterns can alter community distribution, composition and function. By determining the range of natural variation in assemblage composition, abundance and elevational distribution, park managers will be able to detect impacts from stressors that include changes in water quality, harvest pressure, pollution, and global climate change*
2. Determine the temporal and spatial change in physical habitat types. ***Justification:*** *Intertidal organisms are intimately linked to particular substrate types. Habitats are vulnerable to change through anthropogenic shoreline alteration (i.e. jetties, bulkheads) and through geomorphic change associated with natural oceanographic processes (e.g. erosion, longshore currents) and with anthropogenically influenced oceanographic processes (e.g. global climate change). Determination of changes in habitat distribution and abundance can*

directly influence management decisions that can lead to the limitation of habitat alteration.

3. Determine long-term trends in intertidal water temperatures across the range of coastal nearshore oceanographic cells. (Note: A nearshore oceanographic cell is a large area of nearshore water that has distinct physical/chemical properties due to large scale oceanographic processes such as upwelling, currents and bathymetric influences.)
   Justification: *Intertidal temperature is an important factor in determining the persistence and elevational distribution of intertidal organisms due to their species-specific physiological tolerance thresholds. Temperatures experienced by intertidal organisms are not easily predicted by nearshore water temperatures due to the influences of intertidal topography, substrate type, wave exposure, and current patterns. Determination of intertidal temperatures will directly inform park managers about how changes in oceanographic processes affect intertidal organisms and will enable managers to better interpret any changes in intertidal invertebrate & macroalgal communities.*
4. Determine long-term summer trends in nearshore marine water quality.
   Justification**:** *This objective relies upon NOAA, and other agencies for data collection. On the OLYM coast, and elsewhere in the region, NOAA deploys a set of nearshore buoy arrays that record a variety of water quality parameters during the summer. This monitoring only occurs during the summer on the open coast due to the high potential to loose equipment during winter storms. While the NPS-Vital Signs Marine/Estuarine workgroup recommended a core of 4 required parameters (Temp, Salinity, DO, pH), it is infeasible to collect all of these data with the appropriate frequency. These recommendations appear to be based upon east coast parks that emphasize open water marine/estuary monitoring. These recommendations are far less appropriate for west coast intertidal-based parks. In NCCN parks the harsh, remote nature of the marine environment limits the ability to meaningfully measure the full suite of parameters, especially, DO, pH, salinity. For these parameters, there is no feasible way to deploy remote dataloggers, or to regularly visit remote locations for in-person measurement. Thus, this protocol recommends reliance upon partners in the nearshore for data from proximate locations.*

Basic Approach:

The proposed approach to intertidal monitoring is a combination of intensive regular monitoring and a periodic habitat inventory (see table 2 below for design details). Intensive regular monitoring focuses upon change in community composition/distribution in rocky platform and sand beach habitats. These habitats are major habitat types in the NCCN. It is not recommended to pursue monitoring of mixed-coarse (cobble) habitat communities. These highly disturbed habitats are physically complex, making them difficult to sample in a reliably quantitative fashion. Preliminary work in these habitats suggests that diversity and abundance data are highly variable in space and time, likely due to the patchy, dynamic nature of these habitats.

Rocky Platforms: Two types of rocky platform monitoring are proposed, comprehensive" and "elevational transect" surveys. Comprehensive surveys are single grid surveys that cover an area from the high intertidal to the low intertidal. One to two comprehensive survey sites would be randomly located in appropriate habitat within each nearshore oceanographic cell. Within each survey grid (approximately 30m x 20m) the elevational distribution of sessile invertebrates and macroalgae will be determined by sampling a set of randomized point counts along vertical (to shore) transect lines. A set of randomized quadrats along these lines will sample the distribution and abundance of mobile species. This survey type allow for the detection of elevational shifts (in addition to abundance changes) of major space occupying organisms. Methods for this survey type are still being refined. This survey type is expected to be adopted at all west coast NPS intertidal parks (CABR, CHIP, PORE, REDW) to allow coast-wide comparisons of trends.

Elevation transects are randomly located horizontal (to shore) transects that enable finer precision to detect changes in abundance at particular elevational levels. As in comprehensive surveys, sessile abundance is estimated by random point count techniques, and mobile species abundance is estimated using quadrats. Two elevation transect sites will be chosen for each nearshore cell. At each site, there will be a transect at each of three elevational levels (high, mid and low). This sampling procedure is consistent with historical NCCN intertidal monitoring. Methods for this survey type are also currently being refined to determine appropriate sample size that yield acceptable power levels.

Sand Beaches: For each nearshore oceanographic cell, two sand beaches will be randomly chosen for monitoring. At each beach, two vertical (to shore) transects will be randomly located along the beach. Transects start from the high tide and extend approximately 75m towards the sea. At 6 elevations, 4 replicate sand cores will be taken and passed though a fine-meshed sieve. All infaunal organisms are enumerated. This method provides inferential distribution and abundance information on sand beach communities.

Water Quality: A three-pronged strategy is proposed for marine water quality monitoring in the NCCN. The first prong is to measure temperature directly in the intertidal zone by deploying a network of relatively inexpensive temperature dataloggers. A minimum of two temperature loggers will be deployed in each nearshore oceanographic cell. Dataloggers can be deployed for over a year, requiring annual data downloading and datalogger swap-outs/maintenance

The second prong is reliance upon other agencies that collect salinity, pH, and DO measurements in the nearshore marine waters. For example, off of the OLYM coast, the Olympic Coast National Marine Sanctuary (OCNMS) conducts an oceanographic monitoring program. As part of this program OCNMS-NOAA maintains a series of nearshore buoy arrays that measure these parameters.

The third prong is the use of intertidal community structure as an integrative indicator of marine water quality. Certain species groups in the extant intertidal communities have

tolerances/preferences for various conditions. For example, certain macroalgal species flourish and occupy greater area coverage under nutrient enrichment, while other species are favored/disfavored by changes in temperature regime or exposure to pollutants such as oil.

Periodic Habitat Inventory: It is proposed to survey the entire coastline once per decade using digital video from a low-flying fixed-winged aircraft. Video will then be reviewed and shoreline segments will be classified according to the British Columbia habitat classification standard. Change in habitat type will be determined by comparing percentage of coastal habitat types across years.

Month	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Week	1	15	1	15	1	15	1	15	1	15	1	15	1	15	1	15	1	15	1	15	1	15	1	15
Hiring																								
Training																								
Data Collection																								
Data Entry																								
QA/QC																								
Reporting																								
Records Mgmt																								

Principal Investigator/NPS Lead: Steven C. Fradkin (OLYM)

Development Schedule, Budget, Expected Interim Products:

Protocols proposed here are still in development. It is expected that protocols will be finalized by the end of FY06, with a draft protocol available for peer review by December 31, 2006. See below for a draft budget to conduct monitoring at OLYM.

Table 1: Budget (based on proposed effort at OLYM)

Personnel -Sand Beach sampling	**Job component**	**PP**	**Cost**
GS5 seasonal	field data collection	5	5300
GS5 seasonal	field data collection	5	5300
GS7 Permanent STF	data analysis and reporting	1	2100
		11	**$12,700**
Personnel - Rocky Platform sampling			
GS12	Field data collection, data analysis and reporting	6	
		6	**$0**
Personnel - Water temperature sampling			
GS5/6 seasonal	collateral w/ sand beach sampling	3	0
GS5/6 seasonal	collateral w/ sand beach sampling	3	0
GS12			
		6	**$0**
Personnel - Data entry/processing			
GS5/6 seasonal	data entry/processing/ QAQC	2	2,340
GS12			
		1	**$2,340**
Vehicles (GSA Rig @ $500/month)	2 months field season		**$1,000**
Services			
Supplies and Equipment			
(Sampling bottles, camping gear, misc field gear)			**$2,184**
	GRAND TOTAL =		**$18,480**

Table 2: NCCN Vital Signs Intertidal Monitoring

Target Parks - OLYM, FOCL
Target Population - Rocky platform: Inferential design: Random-sample of habitat segments, blocked by nearshore oceanographic cells (NS cell)
Sand Beaches: Random-sample of habitat segments, blocked by nearshore oceanographic cells
Water quality: Spatially distributed array of intertidal temperature loggers, blocked by nearshore oceanographic cells

Two survey types: (1) Regular monitoring, (2) Periodic inventories
Orange denotes WRD required core parameter
Core column denotes striped-down core monitoring program

INDICATORS	Survey Type: Reg Mon	Survey Type: Per Inv	Sampling: # sites/NS Cell	Sampling: Sampling Frequency	Method	Inference	Response Variables
Biological							
Invertebrate & Macroalgal Community							
Rocky Platform Habitat	m		1-2 per NS cell	Biennial Alternating	"Comprehensive surveys" = 30mx20m grid w/horizonal & vertical sp. Mapping. Complies with Coastal West Coast NPS Units	Nearshore Cell, Park, Region	% cover, abundance, species richness
			2 per NS cell		"Horizontal transects"= 2-10m transects @ 3 elevations (VH,H,M)		% cover, abundance, species richness
Sand Beach Habitat	m		2 per NS cell	Annual	Perpendicular transects with replicate cores		% cover, abundance, species richness
Water Quality							
Temperature	m			Continuous	intertidal temperature datalogger	Nearshore Cell, Park, Region	times series of means and stnd dev
Invertebrate & Macroalgal Community	m			Annual	*see above*		*See above*
Physical							
Habitat Survey		i		Decadal	aerial video survey	Park	Change in % habitat types